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CARNIVOROUS PLANT NEWSLETTER

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Front Cover: *Sarracenia flava* var. *rubricorpora* near Sumatra, Florida. See article on page 6.

Back Cover: *Sarracenia leucophylla* 'Hurricane Creek White'. Photograph by John Hummer. See article on page 19.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Contributors should review the "Instructions to Authors" printed in the March issue of each year. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

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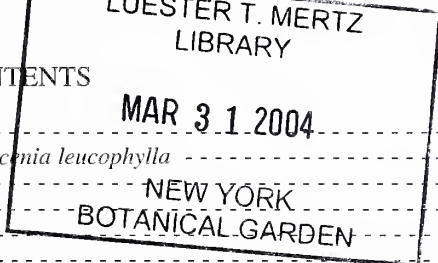
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Volume 33 March 2004

THE SAGA OF THE HURRICANE CREEK WHITE *SARRACENIA LEUCOPHYLLA*

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Keywords: observations: Alabama, pigmentation, *Sarracenia leucophylla*.

A Memorial

Once upon a time, there was, off the Alabama Interstate highway in Baldwin County, south of the Perdido-Atmore interchange of I-65, one of the most striking regions for *Sarracenia* habitation. Roughly 60-80 km (40-50 miles) northeast of Mobile Alabama, and about 110 km (70 miles) north of the Gulf Coast, this area was unique for having a confluence of ranges for uncommon wetland species both carnivorous and non-carnivorous. For years, if not decades, it had been a mecca for biologists, naturalists, as well as carnivorous plant enthusiasts. Four species of pitcher plants grew here: *Sarracenia leucophylla*, *S. purpurea* subsp. *venosa* var. *burkii*, *S. rubra* subsp. *wherryi*, and *S. psittacina*. It was a menagerie of species that you would not have been likely to encounter anywhere else.

It is important to note that, although some of the habitat is privately owned by individuals or families, the majority of the vast amount of real estate that encompasses the region is owned mainly by the International Paper Company.

State Route 61 runs north-south and bisects I-65 right through this savannah habitat. Just off to the north extending 400 meters (1/4 mile) was a hydrologic system consisting of many rivulets and seepage zones, which together was called Hurricane Creek. It meandered out of a bluff as a subterranean watercourse, emerging from the ground about 4 km (2.5 miles) north of I-65. At the creek source, there was a bog system with many specimens of large red *Sarracenia leucophylla* and *S. purpurea* and several species of *Drosera*. It then flowed south towards the interstate. Along the way, there were alternating areas of bog and woodland habitats. About 800 meters (0.5 miles) north of the interstate it opened into a large, rolling savannah. Like the agricultural wheat fields of the midwestern plains, the brushlike inflorescent stalks of hundreds of *Ctenium aromaticum* (a longleaf pine savannah grass of the southeastern coastal plain) swayed to and fro high above the vast numbers of *S. leucophylla*, *S. rubra* subsp. *wherryi*, *S. purpurea*, and *S. psittacina*, as well as natural hybrids. It was in this area that I first observed pure white *Sarracenia leucophylla* (i.e. leaves with the upper one third of the pitcher snow white with no visible red venation). But these plants were not the anthocyanin-free forms—in fact, the crowns were very red and it was only by close examination that I could differentiate these forms from the true anthocyanin-free form which could also be found in this region. Most interestingly, they produced the typical red flower. Even so, these anthocyanin-containing, snow white *Sarracenia leucophylla* along Hurricane Creek were the showiest white forms of the species I had ever encountered during my many years of field work. Plants of this form could also be found in some areas along both sides of the interstate highway system, but the most striking plants I had found grew about 800 meters (0.5 miles) north just off SR 61. (Most of the *Sarracenia leucophylla* at Hurricane Creek were typical plants, only a relatively small fraction were the particularly beautiful ones I am discussing here.) A jeep trail running off SR 61 took you right into a super, huge savannah of *Sarracenia* and other bog flora that carried on for quite some distance. It was an impressive sight!

Unfortunately, in 1996 hundreds of acres of this habitat was not only clearcut for a pine plantings, but the area was also “moonscaped” (i.e. the growing surface was completely

removed, leaving the bare soil exposed), obliterating almost all of the herbaceous plant life! As a lover of the natural environment, it was the worst assault of a pitcher plant savannah I had ever witnessed. We are talking about tens of thousands of unique and uncommon plants in what was probably the prime ecosystem in the region going under.

Luckily, I was able to obtain a few specimens of this unique white form *Sarracenia leucophylla* before the disaster struck, and I selected a few particularly vigorous and attractive clones to carry the name *Sarracenia leucophylla* 'Hurricane Creek White' as a memorial to this destroyed site (see article on page 19).

Thoughts on Anthocyanin-Free Plants

I have come to accept that the white plants from Hurricane Creek (and especially including the cultivar *Sarracenia leucophylla* 'Hurricane Creek White') are far superior to the anthocyanin-free form of *Sarracenia leucophylla*. I have both forms and there is no comparison regarding plant vigor and size. In addition, a large percentage of the anthocyanin-free forms (hybrids excluded) exhibit some physiological anomalies that keep them from ever becoming show pieces. These anomalies include poor growth performance, a higher susceptibility to fungus and infection, and low fertility. The only anthocyanin-free *Sarracenia* I have grown that counter these claims are the *S. psittacina* 'Green Rosette' from Gulf County, Florida (Hummer, 2001), and the *Sarracenia rubra* subsp. *gulfensis* found by Jim Bockowski in the late 1980s. I believe that Sheridan and Scholl have a form of anthocyanin-free *Sarracenia leucophylla* that is fairly vigorous as these forms go, however I have not raised this clone so I cannot make accurate judgements about it.

If my analysis of the anthocyanin-free forms of *Sarracenia* was incorrect, then one would expect to find many more anthocyanin-free forms in the wild, especially in small colonies, which is very uncommon. *S. psittacina* 'Green Rosette' illustrates this point clearly. Where I originally found this clone growing, there were at least half a dozen other specimens in the same general area, and more have been recently reported (P. Sheridan, personal communication, 2001). It is unusually vigorous, and selfs well producing a sizeable crop of seed. Few anthocyanin-free *Sarracenia* do this, with the exception of the northern *Sarracenia purpurea* f. *heterophylla*. This is not a personal attack on anthocyanin-free forms—I have had many anthocyanin-free forms and have made many crosses with them. I have enjoyed raising them very much. These conclusions are based on my many years of field observations and personal growing experiences with many forms and variants of both anthocyanin-free and typical pigmented forms of plants. The anthocyanin-free variants are certainly interesting for what they are, but they are very restricted to being what they are—one can never expect to obtain the breeding dynamics with them that you can with the *Sarracenia* that incorporate the carotenoids and flavanoid compounds that give plants the spectacular colors we are all so awed with when we observe them!

Hummer, J. 2001, New Cultivars: *Sarracenia psittacina* 'Green Rosette', Carniv. Pl. Newslett. 30, p115-116.

LOOKING BACK: CPN 25 YEARS AGO

Tom Story noted a problem still mentioned on modern internet discussions: "In closing I would like to warn all CP growers who have cats of an experience that happened to me lately. As my cats regularly use a catbox of kitty litter, they apparently recognized my terrarium (which I had inadvertently left uncovered) as a catbox and used it as such, with the disastrous result of destroying many of the plants with either urine or burial."

Also, twenty five years ago, Carnivorous Plant Newsletter graduated from being a black and white photocopied set of typed sheets to a printed, color journal very similar to its current format. The Newsletter had "arrived!"

A FIELD STUDY OF *SARRACENIA OREOPHILA*

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Keywords: observations: *Sarracenia flava*, *Sarracenia oreophila*.

Introduction

The area in northeast Alabama is home to some of the most picturesque views one will ever encounter on Earth. The quaint Little River cuts through a canyon that is one of the deepest east of the Mississippi River. Its waters can be deceptive, flowing as tranquil as a quiet summer evening—a small rift of white water no longer than 2 meters (6 feet) in length is all the warning you get before plummeting 25 meters (80 feet) down the side of a cliff. You might notice during your few seconds of free-fall that the great numbers of rhododendrons clinging to the sheer sides of the waterfall are in bloom. Welcome to the home of *Sarracenia oreophila*.

During May 2002 I had the opportunity to be taken on guided tours of several of the few dozen remaining natural *S. oreophila* sites. In order to protect these sites from poaching, I will refer to them using their ICPS location codes¹ of AL009, AL012, and AL015 (Meyers-Rice, 2001). Sites AL009 and AL015 are owned and managed by The Nature Conservancy (TNC). Keith Tassin leads the stewardship effort for TNC-Alabama. With a group of dedicated volunteers, these guys and gals work diligently with allied organizations such as the Alabama Natural Heritage ProgramSM and the US Fish and Wildlife Service to protect and restore rare plant sites within Alabama. Since *S. alabamensis* (i.e. *Sarracenia rubra* subsp *alabamensis*) also occurs within this state, Keith and his allies have the daunting task of protecting two of the most endangered pitcher plant species on Earth.

Due to the wet nature of the areas in which *S. oreophila* grows, many of its former habitats were converted into agriculture ponds. Poaching has been and continues to be a problem with *S. oreophila*. Decades of fire suppression in Alabama have led to the demise of many other sites.

In this area of the country, it is very difficult to reverse the affects of long term fire suppression. If an area does not receive at least a modest burn once every 10 to 20 years, large hardwood trees establish themselves and form a dark canopy over the pitcher plants. A low intensity prescribed burn is likely to do little more than char the lower bark of these large trees. A high intensity inferno could consume them, but a fire of that magnitude is likely to burn so fiercely as to kill the desirable plants, including *Sarracenia*.

In addition you have non-native invasive plants such as privet (*Ligustrum sinense*) and Japanese honeysuckle (*Lonicera japonica*) wreaking havoc at sites. Japanese honeysuckle can put up a good hand-to-vine combat battle in the field and be very difficult if not impossible to eradicate. Two of the very few remaining *S. alabamensis* sites have been degraded by Japanese honeysuckle to the point where they are unmanageable, and may be lost in very short time.

Keith and his group have done a fantastic job reviving many of the nearly doomed sites of these two rare Alabama pitcher plant species. They have discovered additional plant sites by performing these scheduled burns, when a sudden opening of an area causes the once invisible plants to start flowering and pitching. These fine folks care a lot about the long term survival of these plants, and we are all very lucky to have them leading the effort.

¹The first two letters indicate the state, in this case Alabama. The next three digits identify the site location. The ICPS will not release the identities of these sites; the author similarly agreed to respect the secrecy of this site information. Interested researchers can contact the ICPS for additional information about ICPS location codes.

I visited three *S. oreophila* habitats. The first site was AL015. Although about 20 ha (50 acres) in size, the site has only a very small portion suitable for *S. oreophila*; the plants are all confined to an area near a small stream. This site also contains several other very rare plant species. The second site is the AL009. Although only 2 ha (5 acres) in size, it contains many *S. oreophila* plants. There is also ample habitat for further expansion of the population, as it is located on a large low-lying depression. The third site, AL012, is located in a large wet depression near a river, amid a hardwood forest and a few pines. This population seemed very vigorous and of the three sites was the largest in terms of area. There is also much more suitable habitat for the plants to expand into.

Each of the three sites had a topsoil of about 5 cm (2 inches) in depth that was very light and airy, and was similar to a fine grade mulch. Below this was a more dense peat-like material.

It is peculiar that these three populations do not flower exactly simultaneously. Most of the plants at the AL009 had completed their flowering about a week before I arrived. The AL015 site had just passed peak flowering. The AL012 site was just entering peak flowering.

One of my objectives of this field trip was to see which of the characteristics of *S. oreophila* were stable in the wild, and which ones were not. Specifically, I wanted to verify some of the distinguishing characteristics between *S. oreophila* and *S. flava*. Obviously, they have very different ranges, but the grower of cultivated plants may not know the original locations for their plants. I wanted to find other differences that can be used to tell the plants apart. I have grown these two species side-by-side, for more than 25 years, and had grown confident that I could easily distinguish any *S. oreophila* pitcher from any *S. flava* pitcher. Ah yes, ignorance is bliss.

Supposedly, *S. oreophila*, as compared to *S. flava*, has a slightly smaller and more domed lid, a less developed column, a mouth that is rounder to semi-circular in shape, flower petals which are rounder and are a light green in color, and highly recurved phyllodia. The pitcher in Figure 1 portrays what I believed to be the typical characteristics of *S. oreophila*. In comparison, *S. flava* has a large lid, a well developed column area, a mouth which is generally wider than round, a pronounced lip, and a well reduced ala (see Front Cover). Furthermore, it has golden yellow, strap-shaped petals, and large, sword shaped, vertical phyllodia. But are these differences stable in the wild?

Since the three *S. oreophila* locations I visited were separated by a reasonably large distance, I hoped to find some variation of plant characteristics. I was not disappointed! After comparing wild populations of *S. oreophila* and *S. flava*, I was amazed at how similar these species can be. I had been lulled into thinking these species were much more different than they are, probably because of my familiarity with my own plants in cultivation. Similar to how parents of identical twins can readily tell their kids apart, I could tell my *S. oreophila* and *S. flava* apart. But it is a lot different when you start dealing with thousands of plants in different populations. Some of the characteristics used to differentiate these plant species are not always reliable.

Flower Color, Shape, and Size

While *S. flava* reliably produces very dark-golden petals that are long and strap shaped, *S. oreophila* does not have a stable petal color or shape. While many were greenish yellow and oval, others were darker yellow and very elongated (Figure 2). Some of the *S. oreophila* flowers with dark yellow, elongated petals were very similar to those *S. flava*. It could be very difficult to distinguish the two species by flowers alone if you could not compare them side by side.

Sarracenia oreophila flowers that I saw at these sites could rival in size all but the largest *S. flava* flowers in the wild, but they are close enough in size that it would be impossible to use flower size as a factor in distinguishing the plants.

Lid Structure

While each *S. oreophila* plant produces pitchers with similar lids, the lid shape can vary (sometimes dramatically) from plant to plant within a stand of plants. (In contrast, the lids in a

stand of *S. flava* are usually very similar.) While most lids produced by *S. oreophila* were smaller on average than those produced by *S. flava*, some lids were just like those of *S. flava* in size and shape, complete with a long keel.

The way in which the back margins of *S. oreophila* lids flex back towards the column is also variable. Some flex back as much as is typical for *S. flava*, so that the back margins overlapped and formed a lid funnel. Others barely flexed at all and did not even come close to touching. The amount of lid flexing in *S. flava* pitchers also varies, but not nearly as greatly. Their back lid margins touch or overlap each other forming a lid funnel—at the very least they nearly touch.

The lids of *S. flava* are normally held close to the mouth, whereas in *S. oreophila* the lids are typically held higher and sometimes dome over the pitcher mouth. But again I found much variation, and a vaulted lid held high over the pitcher mouth is not a stable trait within *S. oreophila*.

Column Structure

Although the column of *S. oreophila* is known to be a less well defined than that of *S. flava*, and while this is usually true it is not always the case. Some *S. oreophila* pitchers had columns that were as well developed as those of the best developed *S. flava* columns. How well the column was developed seemed to correlate to how far back the lid margins flexed. As I noted above, *S. flava* lid margins flex greatly, while the feature is more variable in *S. oreophila*. Paralleling this, the degree of column development tends to be more variable in *S. oreophila*. A well defined column and large highly reflexed lid does not guarantee that the plant is *S. flava*, but a less developed column and less developed smaller lid does tend to indicate that the plant is *S. oreophila*.

Sarracenia flava columns are normally angled toward the front of the pitcher. The columns of *S. oreophila* typically do not angle as much, but again, there was a degree of variability to the angle in *S. oreophila*.

Mouth Area

The pitcher mouth rim is called the lip, and in *S. flava* the lip is strongly curled. The lip has a well-developed dip in the front of the pitcher mouth, i.e. the lip spout. In extreme cases, the lip spout dips and twists to the side, or dips down as much as 5 cm (2 inches) or more (especially in *S. flava* var. *rubricorpora*). Poorly cultivated plants may not always show this feature well.

In *S. oreophila*, the lip is either small or practically absent. None have lip spouts developed as much as in *S. flava*.

The shape of the mouth opening of *S. oreophila* can vary. Some plants have mouths nearly circular in shape, whereas others have mouths that are elliptical (i.e. the mouths are significantly wider). *Sarracenia flava* normally has mouth openings which are elliptical.

Sarracenia flava pitchers widen or flare greatly in the lip area (see Front Cover). The mouth of *S. oreophila* flares only slightly to moderately (Figure 3).

Pitcher Coloration

Each *S. oreophila* location sported a great variation of pitcher coloration and veining. The most common occurrence were pitchers which contained light internal veining. The spectacular veining of some plants could match that of heavily veined *S. flava* var. *ornata* (Figure 4). In a few plants, red coloration in the pitcher column and mouth filled the gaps between the red veins (Figure 5). Many *S. oreophila* plants are veined only on the inside of the pitchers. In the wild, I have never seen what I believed to be true *S. flava* plants with internal-only venation, but such plants have been observed (B. Rice, personal communication). Some *S. oreophila* pitchers have no red veining, and these can look very similar to all-green *S. flava*.

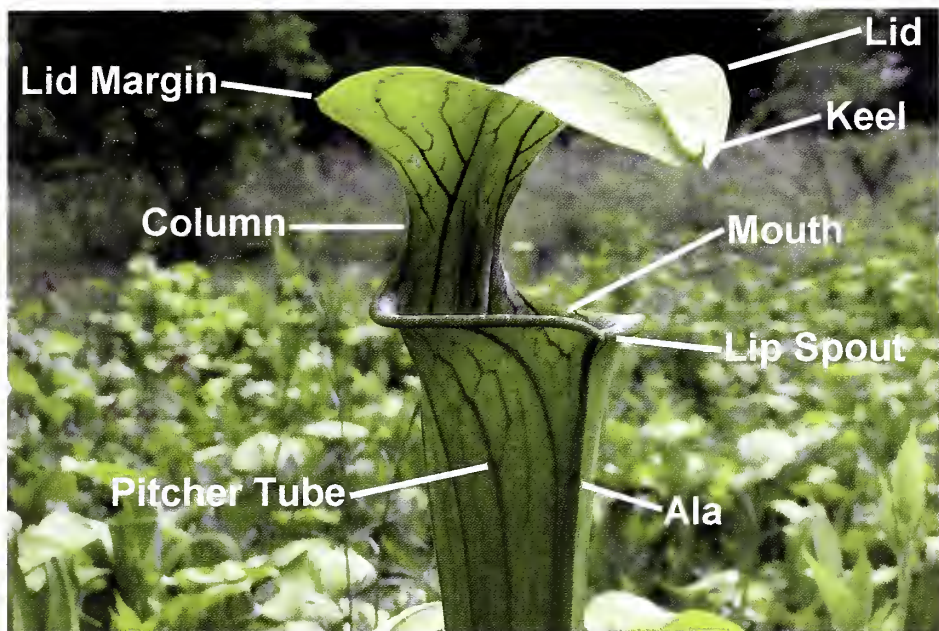


Figure 1: *Sarracenia oreophila* at AL009 with features labeled.



Figure 2: *Sarracenia oreophila* flowers from AL012. Note the long yellow petals, and how the flowers are taller than the pitchers.



Figure 3: *Sarracenia oreophila* at AL009 showing a slightly pronounced lip.



Figure 4: A heavily veined form of *S. oreophila* at the AL012 site. Although similar to *S. flava*, note the smaller lid and absence of a lip spout. Other pitchers in this photograph resemble *S. flava*, but have poorly developed columns and lip spouts.

At most *S. flava* sites you will observe surprisingly little pitcher color variation. Yes, there are quite a few color variations of *S. flava*, but plants within a single stand are usually so similar as to appear to be clones of each other. Meanwhile, you would be hard-pressed to find any two *S. oreophila* plants with identical coloration within the same stand.

Flower and Pitcher Height

The flowers of *S. oreophila* tower over the pitchers (Figure 2), while with *S. flava* the flowers are dramatically shorter than the pitchers. This difference between the two species is quite stable: if the flower is taller than the pitchers, it is *S. oreophila*, but if the flowers are shorter than the pitchers, it is *S. flava*.

Mature *S. oreophila* plants typically stand between 50-70 cm (20-28 inches) tall, while mature *S. flava* pitchers average slightly taller. I have found pitchers of both species in the wild that exceeded 100 cm (40 inches) tall. Because of this great variability, this feature is of little help in distinguishing the species.

In approximate terms, *S. oreophila* pitchers peak in quality at the same time as for *Sarracenia flava*. The pitchers of both species wither in mid to late summer, although they are prolonged if the habitat stays moist.

Phyllodia and Alas

Both species create non-carnivorous phyllodia during the winter, which result from the simultaneous exaggeration of the ala and the reduction of the tubular pitcher and lid. The phyllodia of *S. oreophila* bend back into the ground and form a rosette. The phyllodia of *S. flava* are taller and are sword shaped. This difference between the species is quite stable.

I noticed that many *S. oreophila* plants had phyllodia that curled to the side, rolling themselves up. This rolling effect may have been caused by the heat of late winter burns, although it has been observed on plants in cultivation. Phyllodia rolling was observed on nearly all plants at AL015 and a few plants at AL012.



Figure 5: An *S. oreophila* pitcher at AL009 sporting a waxy red mouth.

The ala on well developed *S. oreophila* pitchers can be greatly reduced, sometimes to the point of being difficult to see near the mouth of the pitcher. Unfortunately, there is little or no difference between the alas of *S. flava* and *S. oreophila*. Although a stable trait, the size of the ala in both species is influenced by the amount of shade—a reduction in light produces more developed alas.

A Summary: *S. oreophila* vs. *S. flava*

I found only two rock solid plant characteristics that are different and stable between *S. flava* and *S. oreophila*: flower height and phyllodia shape. Coloration and veining is also a help unless you are dealing with either the all-green or heavily veined forms. Flower scent may also be an aid, as the flowers of *S. flava* can produce an unpleasing scent.

When it comes to distinguishing the species by pitcher structure, you must rely upon all factors as a whole. I could usually distinguish the two because the *S. oreophila* pitcher was missing a feature characteristic of an *S. flava* pitcher. But you must broaden your focus—lid size by itself can not be a sure-fire distinguishing factor (I found many large lidded *S. oreophila* plants), nor can the column area, lip spout, mouth opening and flare, etc. You must combine all of these factors. I have even found an occasional *S. oreophila* plant which put together the entire package of large low lid, well-developed column, a lip spout, and a wide, flaring mouth opening—these pitchers came very close to mimicking *S. flava*. In these cases, flower height and phyllodia shape were the only remaining ways to differentiate the two species.

So, although your cultivated *S. oreophila* and *S. flava* plants may appear only slightly similar, rest assured that there are pitchers of these two species in the wild that are nearly identical. *Sarracenia oreophila* and *S. flava* may be close cousins, but it certainly looks like they kissed sometime in the distant past.

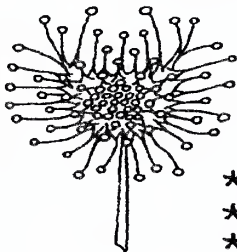
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PARTY TIME—MIX AND MATCH

GREG LUM • 510 Lansdale Avenue • San Francisco, CA 94127 • USA • grrlum@aol.com

Keywords: cultivation: bog gardens, California, *Disa*.

Some of you have, but some have not, heard about mixing *Disa*—the South African orchid—with insectivorous plants. Below is a short summary of my experiences with growing *Disa* and carnivorous plants together.

I started raising carnivorous plants when I was 15 years old. My mom bought me my first cobra lily and Venus flytrap from a supermarket in Michigan. I composed my first member's note in Carnivorous Plant Newsletter in 1991 (Carniv. Pl. Newslett., 1991, 20:3, p67). It talked about how more people should be involved with their local carnivorous plant society. I believe I was a little over zealous for being only 18, and wanting to go on exotic field trips to visit tropical carnivorous plants in their native habitat.

I learned much over the next 11 years, as I raised and have raised carnivorous plants during my high school, college and post-college years. (There were a few years that my collection did not look so hot because of school and work.) Whenever I had a party in college, guests always made my *Nepenthes* in a fish tank the talk of the party!

Currently, I have only about 75-80 carnivorous plants and all are planted in handcrafted pots designed by a Bay Area artist (Marni Turkel). My collection consists of *Sarracenia*, *Drosera*, *Pinguicula*, *Dionaea*, *Darlingtonia*, *Heliophora*, *Cephalotus*, *Utricularia*, *Brocchinia*, *Genlisea* and *Nepenthes*. At one point I had over 200 carnivorous plants (and that is quite a few since I also had over 200 orchids and other exotic plants to deal with). Since then I have cut back my collection, and now I have only half a dozen pots of orchids. Many of my *Disa* can be found at California Carnivores (in Sebastopol, California) and at a few private Bay Area carnivorous plant collections.

It was not until after my college years that I started experimenting with adding *Disa* orchids to my carnivorous plant bog gardens. Actually it began by accident, as I was trying to save a struggling *Disa* from perishing altogether. The procedure was fast; I just took the *Disa* from its pot and placed it in the bog garden in peat moss amongst the Venus flytraps, sundews and pitcher plants. The plant grew extremely well and, having a leaf span of about almost 38 cm (15 inches) long, it started to take over the bog garden itself.

Disa plants are somewhat easy to grow but like all plants they definitely have their strict rules to good growth. These South African natives are found on mountain slopes in full sun, near waterfalls or streams, in constantly wet soils, and are often bathed in a cool, humid mist. In short, they thrive in the same conditions as most carnivorous plants: bright light, constantly moist, acidic soil, and constantly moist in pure water. In cultivation, fertilizers are not necessary but can be used at a very diluted strength such as a 30-10-10 or a 20-20-20 at 0.2 ml fertilizer per liter water (1/8th teaspoon per gallon). I do not use any fertilizers on my plants and still get flower spikes that are over 60 cm (2 feet) tall. Air circulation and cleanliness around the growing area is also of utmost importance in order to reduce the risk of infection of various fungi such as *Cylindrocarpus* that can lead to the rotting of the plants. Cleary 3336, a wettable powder can be used to help prevent some of these fungi from turning into a disaster.

Disa in my bog gardens are planted in sphagnum peat moss, mixed with a little perlite and sand. I may add a top-dressing of live sphagnum moss. They are planted right beside *Sarracenia purpurea*, *Drosera*, and Venus flytraps.

All of my bog gardens are planted in drained, plastic planter bowls or plastic planter boxes. They rest on shelves under a balcony and receive direct sun for only a few hours a day early in the morning. To keep them cool, even in the hottest areas of my yard, I give them as much as

Volume 33 March 2004



Figure 1: *Disa* Foam 'San Francisco' FCC/AOS. Photo by Jeremy Beckman.



Figure 2: *Disa* Veitchii hybrid. Photo by Jeremy Beckman.



Figure 3: *Disa* Foam 'San Francisco' FCC/AOS growing in mini-bog gardens. Photo by the author.

50% shade. I grow my *Disa* plants in undrained pots so the peaty mix can dry out a little—not keeping them constantly soaked helps lessen the chance of rotting. Soon I will be dividing and placing some of the plants that I want to keep in ceramic bowls that have drainage holes and give the rest away.

Nowadays I raise my *Disa* plants in a lighter mix to improve aeration among the roots, but the results are the same as in the peaty mix. The key to growing a healthy *Disa* is the acidic pH (5-6) of the soil, and using absolutely the purest water (below 100ppm) one can find. A little bit of sun, and keeping the growing areas moderately clean, will help keep diseases to a minimum. Temperature ranges for growing *Disa* are between 4-27°C (40-80°F), but they can withstand extremes outside of this for short periods. The main flowering season is from May to August. *Disa* never really go dormant. The plants reproduce vegetatively much like common bromeliads—the main flowering stem from the mother plant dies and is replaced by new offshoots. Repotting should be done in late fall or early spring, using fresh media, trim away dead leaves at this time.

Since I sold and traded most of my *Disa* plants this year for rarer carnivorous plants I have only a limited supply of the highly awarded *Disa* Foam 'San Francisco' and *Disa uniflora* 'Big Pink' available for trade. I know several people in the greater Bay Area in California from whom I have purchased plants, and you can purchase plants from them as well. Email me for contacts.

NAMES OF CULTIVARS REGISTERED IN 2003

- Pinguicula* 'Libelulita', B.Rice & E.Salvia, Carniv. Pl. Newslett. 31: 83 (2002), 1 Apr.
Sarracenia 'Chas' Brew', C.Brewer & S.Ploszak, Carniv. Pl. Newslett. 32: 34 (2003), 13 May.
Sarracenia 'Cobra Nest', J.L.Booman, Carniv. Pl. Newslett. 32: 34 (2003), 13 May.
Sarracenia 'Scarlet Belle', B.Hanrahan, Carniv. Pl. Newslett. 32: 34 (2003), 13 May.



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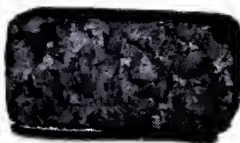
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SPECIAL REVIEW: GULF COAST CARNIVOROUS PLANTS POPULATIONS—DVD

Reviewed by Carl Mazur



A few months ago I noticed a posting on the carnivorous plant list-serv about a DVD project that list member Jim Miller was working on. I lurked for a while, wondering what the project was all about. After reading a few posts, I decided to contact Jim myself for the low down. To my surprise, I learned he was putting together a DVD dedicated to the carnivorous plant populations of the Gulf Coast. The best part, however, was that he was planning on making it available to other carnivorous plant enthusiasts. Great idea! What really caught my attention about the project was that proceeds from the sale of the DVD were going to be donated to The Nature Conservancy and the ICPS to aid in carnivorous plant conservation efforts. I didn't know exactly what I was expecting to see in the final product, however, the wait proved to be worth it.

When I got my copy of the DVD, I eagerly put it in my DVD player. I was greeted with a very professional opening sequence and DVD interface; it was like store bought disk! It even had a scene selection menu... I pressed PLAY.

Now, if you are expecting a scientific rundown on bog habitats, native bog flora, genetic diversity and an explanation of the effect of hybridization and introgression on the biodiversity of pitcher plant populations, you will be disappointed. If you are expecting a detailed breakdown of carnivorous plant species that inhabit the Gulf Coastal regions of the USA, again, you will be disappointed. If you are expecting an answer to the meaning of life... You get the picture. So what is the DVD like?

The best I can offer as a comparison are those relaxing CD's you can buy in nature stores. You know—those soothing sounds of thunderstorms or ambient sounds of the forest or ocean. Those CDs are soft, soothing, tranquil and relaxing. This DVD is like that. When I watched it, I was taken on a tranquil, relaxing journey through the carnivorous plant habitats of the Gulf. If you have never been to Gulf Coast, it certainly gives you a great feel for what the carnivorous plant habitats are like. The quality of the footage is exceptional. The DVD includes large scenic panoramic views of habitats as well as stunning close-ups. The detail and beauty of plants is clearly captured. There is no voicing or narration to distract from the visuals throughout the entire run of the DVD—the audio consists of actual outdoor bog sounds interspersed with mellow cello music; both compliment each other and add to the serenity of the experience.

The DVD focuses primarily on *Sarracenia*, likely because it is the most prominent carnivorous plant genus of the Gulf Coast. There was also a clear bias for *S. leucophylla* and *S. flava*, with the two species and their hybrids taking up a good share of the screen time. However, other *Sarracenia* species of the Gulf Coast enjoyed much time in the lime-light. The least represented *Sarracenia* was *S. purpurea* subsp. *venosa* var. *burkii* (*S. rosea*), with only one shot during the DVD's roughly 90 minute running time. *Sarracenia psittacina* was also poorly represented. *Drosera* and *Utricularia* were also lacking in terms of percentage of time they found themselves on the screen. The *Pinguicula* coverage focused primarily on *P. ionantha*.

As an added bonus, there are a number of still pictures at the end of the DVD, featuring excellent photos of carnivorous plants in habitat taken from Jim's personal photographic collection.

All in all, this DVD is a worthwhile investment, especially considering the proceeds are going to help the very habitats you'll be watching. If you are fan of *Sarracenia* and have not been lucky enough to visit carnivorous plant habitats in the Gulf Coast of the USA, then this DVD is a must as it shows you firsthand how and where these plants grow. There is nothing quite as impressive as standing in field of *S. leucophylla* in the wild; the sight can be overwhelming. Unfortunately, it is getting harder and harder to do this as more and more habitat is falling to development and what many people call progress.

This DVD can be purchased directly from Jim Miller for \$49.95 (US), including shipping. His email address is jim_miller@mindspring.com. For more information or to like to see clips from the DVD, you can visit the ICPS website (www.carnivorousplants.org).

NEW CULTIVARS

Keywords: cultivar: *Dionaea* 'Clayton's Red Sunset', *Nepenthes* 'Hortulanus Otten', *Pinguicula* 'Florian', *Sarracenia* 'Bug Scoop', *Sarracenia leucophylla* 'Hurricane Creek White'.

Sarracenia 'Bug Scoop'

Submitted: 21 February 2002

The parentage of this plant is *Sarracenia* $\times$ *courtii* $\times$ *S. leucophylla* = (*S. purpurea* $\times$ *S. psittacina*) $\times$ *S. leucophylla*. The cross between the *Sarracenia* $\times$ *courtii* and *Sarracenia leucophylla* parents was made by the author on 20 March 1999. The *Sarracenia leucophylla* parent was from Chipola, Florida.

This cross exhibits the bug-capturing lure of *Sarracenia leucophylla*—as soon as each new pitcher opens, insects are attracted to become food for the plant. The coloration inherited from the *Sarracenia leucophylla* is definitely visible, but the flared pitcher opening is more similar to that of *Sarracenia* $\times$ *courtii*. This is a very vigorous clone. Vegetative propagation will be needed to keep the features of this plant. See Figure 2.

The cultivar was named on 21 February 2002 by the author.

—DEAN COOK • 91650 Prairie Rd. • Junction City, OR 97448 • USA • cooks@flytraps.com

Sarracenia leucophylla 'Hurricane Creek White'

Submitted: 8 September 2002

As I described in my other article in this issue (see pages 4-5), Hurricane Creek Alabama was a site with a beautiful kind of large, snow white *Sarracenia leucophylla*. I obtained specimens from this site before it was completely destroyed, and have found that these plants are still remarkably beautiful in cultivation. I have designated the cultivar name *Sarracenia leucophylla* 'Hurricane Creek White' (see Back Cover) as a memorial for the white plants from Hurricane Creek.

Since having raised this plant under different conditions (both natural and artificial) for over twelve years, I can attest to not only its adaptability and robustness, but also its spectacular beauty especially in the late summer and fall when prime leaf pitcher production occurs. Under optimum environmental factors such as proper hydrology, soil composition, and sunlight, it reproduces vegetatively well and produces an abundance of seed even when selfed. (Seed production is a good way to raise a large number of *Sarracenia* that have the characteristics of this cultivar. In order to maintain this cultivar's unique hardiness, color, and size characters, do not attach the cultivar name to any seedlings that do not show the large white pitchers of this *Sarracenia leucophylla* cultivar.) It has shown an apparent strong resistance to disease and infection by both fungus or bacteria as evident by the absence of any documented mortality in any of the specimens over the twelve year period I have carried them. In brief, it is a superb specimen for growing by anyone who likes an attractive and dependable *Sarracenia*.

It is important to reiterate that this very white *Sarracenia leucophylla* cultivar is not anthocyanin-free. When one sees this cultivar for the first time, it is easy to mistake it for the anthocyanin-free form often sought after by many carnivorous plant admirers. Mature late summer leaves are a bright white with no visible red venation. The basal crowns are red, but require close inspection to see this feature. Only if there is some type of damage to the leaf pitcher will a red infusion around this injury be visible. The leaf production in spring varies from a few nice leaves to occasionally none at all, especially if there is heavy flower production.

—JOHN H. HUMMER • 23500 Old CC Road • Rutherglen VA 22546 • USA

Submitted: 5 December 2002

It was 1995 when in the collection of the Leiden Botanic Garden, The Netherlands, two of the Bornean *Nepenthes* were flowering simultaneously. One of them was *Nepenthes hirsuta* and producing male flowers, the other one was the very distinctive species *N. bicalcarata*.

Being a horticulturist I was well aware of the rare combination and also quite curious, normally we only grow species in our collection but this was a nice opportunity to make a cross-pollination between these two species. After three years when the seedlings of this hybrid produced their first nice pitchers, I made a selection of five individuals with a variety in pitcher size, form and color. I believe one is worth growing as a new cultivar, because it is so different in size and form (see Figure 1, page 21).

This cultivar is distinguished by its very robust lower pitchers which measures about 18 cm (7 inches) in length, and the opening of the mouth is between 6 and 8 cm (2.5-3 inches) wide. The interior of the pitchers is almost lime green and the typical teeth of *N. bicalcarata* are well presented. The entire exterior of the pitcher is lime green with brown hairs which presents a dark golden glow in full light, and the pitcher wings are well formed. The upper pitchers are somewhat smaller but with the same external texture, are more bulging, and narrow towards the tendril, the latter being covered with long brown hairs. The pitcher's lid is slightly more rounded than the lid of the lower pitcher.

To maintain these unique characters, this cultivar should only be reproduced by vegetative means.

It is named in honour to Mr. Karel Otten, former Curator of the Botanic Garden in Gent, Belgium.

—ART VOGEL, Assist. Curator • Leiden Botanic Garden • Rapenburg 73• 2300 RA Leiden • The Netherlands

Pinguicula 'Florian'

Submitted: 9 March 2003

This new cultivar originated from a cross I did in 1998 between *P. debbertiana* and *P. jamaicensis* (the latter plant was a clone with particularly pale flowers). When I sowed the resulting seed in 1999, I obtained several seedlings. When these matured, I retained one plant which had the most interesting flower. I have named the plant *Pinguicula* 'Florian', after my oldest son's first name.

The hybrid has two different rosette types. The winter rosette consists of up to 100 spatulate, non-carnivorous winter leaves, each up to 2.5 cm long and up to 0.6 cm wide. These are mostly green, but sometimes the leaves can be green with red highlights.

The summer leaves are less numerous (up to 25), and are spatulate to obovate in form with the outermost part of the leaf having an upturned margin. The coloration of the leaves is mostly green-brown to green-red.

The plants flower mostly when in the winter rosette stage, and produce up to 5-8 flowers per year. See the photograph of flower in Figure 3.

The two corolla lips form an angle between 20 and 45 degrees. The two lobes of the upper lip overlap slightly and are spatulate to obovate in form, up to 1.2 cm long and 0.9 cm at the widest point. The three lobes of the lower lip are also spatulate to obovate, up to 1.5 cm long and 0.9 cm at the widest point. The lobes are pink, with darker parallel veins that run from the lobe base into the throat. The proximal palate surface bears two rows of yellow to light green hairs. The corolla tube is short (0.2 cm), with two rows of yellow hairs at its base. The outside of the tube is whitish to pale green, and also bears parallel venation. The (light green) spur can be up to 1.2 cm long and bears brown to reddish venation. All five calyx lobes are obovate, light green and approximately 0.4 cm long. The lower two calyx lobes are almost parallel to each other. The stigmata is ochre. The flower stalk is up to 16 cm long, and bears some glandular hairs near the top.

This cultivar has been distributed to growers world wide since 2001, and is now established in several collections. More photographs of it, and its parental plants can be seen on my website <http://www.gluch.info>.

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Figure 1: *Nepenthes* 'Hortulanus Otten'; lower pitcher (left), upper pitcher (right). Photographs by Art Vogel.

Dionaea 'Clayton's Red Sunset'

Submitted: 31 March 2003

This plant is an all red flytrap which I have named *Dionaea* 'Clayton's Red Sunset'. It regularly grows up to 25 cm (10 inches) across, although extremely slowly, and is one of the wonders of the flytrap world. It first came to light twelve years ago, having originated from a batch of seed imported into Australia from the U.S.A. The features which make this cultivar different from other red flytraps (such as *Dionaea* 'Red Dragon' or *Dionaea* 'Red Piranha') are the following:

A)The petioles are almost always long and thin. The other red flytraps have quite wide petioles, especially during the winter.

B)During the winter, this cultivar totally loses its leaves, at least when grown in a Mediterranean climate. The other red flytraps retain at least some of their leaves.

C)This plant is totally red, except for the teeth on immature traps, which are yellow. *Dionaea* 'Red Dragon' incorporates green as part of its coloration at some time during its growth cycle.

D)The color of this cultivar is a deeper, darker red than the other currently named red flytrap cultivars. It becomes almost black in the summer if exposed to full sunlight.

E)The marginal spines on this cultivar are normal, and not sawtooth as in *Dionaea* 'Red Piranha'.

To keep this cultivar true to its name, it should be reproduced by vegetative means. It responds well to standard flytrap cultivation methods, but takes up to four years to mature. Plants are available from our nursery. See Figure 4.

—COLIN CLAYTON • Triffid Park • 257 Perry Road • Keysborough • Victoria 3173 • Australia • triffids@triffidpark.com.au



Figure 2: *Sarracenia* 'Bug Scoop'.
Photograph by Dean Cook



Figure 3: *Pinguicula* 'Florian'. Photograph
by Oliver Gluch.



Figure 4: *Dionaea* 'Clayton's Red Sunset' growing in a 17 cm (7 inch) pot.

THE SPECIAL RELATIONSHIP BETWEEN *NEPENTHES* AND TREE FROGS

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Keywords: ecology: animal interactions — observations: China, *Nepenthes mirabilis*.

We have been observing the wild *Nepenthes mirabilis* for eight years in the valley in Zhuhai City, Guangdong Province, The People's Republic of China, and have discovered a special relationship between *Nepenthes* and tree frogs.

When we first saw a living frog in the pitcher of the *Nepenthes*, we thought that the frog was trapped and captured (see Figure 1). When we first touched the plant's pitcher, the first reaction of the frog was to rapidly dive into the digestive juice with its eyes shut. After a period of tranquility, the frog stuck its head out of the juice and groveled on the inner side of the wall of the pitcher. It seemed that the frog was not going to wait helplessly for the end of its life, but was as comfortable as if in its own "home" or shelter. While we were taking pictures, we cut a hole in the wall of the pitcher. While fluid drained out, the frog did not try to flee. Only when we forced it out of the pitcher with a small tree branch, did it jump out through the hole we had cut.

What on earth is the relationship between *Nepenthes* and tree frogs? And how do the tree frogs enter the pitcher?

In order to solve the mystery we searched for another pitcher with a frog in it. We found a pitcher containing a frog, but we did not disturb it. When we revisited the pitcher the next day, the frog had disappeared. Obviously, the frog left the pitcher by itself.

The third time we saw a frog in a pitcher we were ready with an experiment. We dangled into the pitcher a pebble on a fine thread. This was intended to mimic an insect foraging for food near the entrance of the pitcher. All of a sudden, the frog jumped from the lower part of the pitcher, caught the pebble, immediately spat it out when it found it was not a prey, and returned to the bottom of the pitcher. This time it went deep into the juice to hide itself. After a while when we shook the pebble again at the entrance of the pitcher, the frog tried to go deeper into the juice (see Figures 2, 3). Ten minutes later we came back, but the frog in the pitcher was gone. How did it get out?

The fourth time we found a frog in a pitcher, we waited patiently to watch what it was doing. The frog stayed on the inner side of the wall without any movement. Suddenly a small insect flew over the entrance, the frog jumped up and caught it. We forced it out with a small tree branch but it crawled slowly out of the pitcher into the grass. It seemed that it came out against its own will (see Figure 4).

The fifth time when we found a frog in a pitcher, we wanted to take pictures of how it got out of the pitcher. We focused the camera and waited a long time but the frog did not move. We could do nothing but try to lure and disturb it to see if it could jump out of the pitcher. When we again used the method of mimicking an insect at the entrance, the tree frog drew back into the juice. When we no longer disturbed it, it crawled up to the upper part of the pitcher, waiting. Finally we knocked the pitcher with a small tree branch, the frog at last jumped out of the pitcher. Fortunately we succeeded in taking pictures of how the frog was jumping out. But we did not use a professional video camera and the movement of the frog jumping out of the pitcher was no more than a blurry contrail.

Through the five observations, we can draw several conclusions. First, the *Nepenthes* pitcher cannot capture tree frogs. The frogs can easily move in or out of the digestive fluid, and can easily climb the pitcher walls. They can easily enter or exit the pitchers. Second, the fluid in the pitchers, which can digest insects, has no harmful effect on the skin of the tree frogs. That the frogs can withstand the digestive juices is remarkable to us, because we measured the acidity of many pitchers and found the pH in them was as low as 2. How they withstand the digestive juices deserves additional research. The mucilage (probably a complex mixture of oligosaccharides) produced by the skin of the frog is probably a sufficient barrier to the acids and enzymes present in the pitcher fluid, and only water can enter this protective coat (J. Schlauer, pers. comm.). In fact, the digestive juice provides a good, wet habitat for these amphibians.

The tree frogs in *Nepenthes* pitchers are not captured organisms awaiting their doom, but instead are "waiting for windfalls." The honey on the entrance of the pitcher lures many small insects, which the frogs wait for. It is not only an easier way for them to capture insects but also reduces the danger of being captured for food by their predators. Tree frogs seem to live a parasitic life in the pitcher of the *Nepenthes*, or may even be partners with the plants.

The relationship between living creatures is more complicated than we can imagine. The mutual dependence, interactions, relationships, and co-evolution are of special significance in the maintenance, stabilization, and balance of the biogeocenose.

It is necessary for us to preserve these plants and their habitats to make a deep study of them.



Figure 1: A hole was cut on the wall of the pitcher but the tree frog did not try to come out.



Figure 3: The frog at the bottom jumped onto the entrance to catch the pebble.



Figure 2: We shook a pebble tied by a fine thread to mimic an insect coming to the entrance of the pitcher.



Figure 4: We forced the tree frog out of the pitcher into the grass. It seemed that it came out against its own will.

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12th December, 2003
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EXPERIMENTS WITH HIGHLAND *NEPENTHES* SEEDLINGS: A SUMMARY OF MEASURED TOLERANCES

ROBERT SACILOTTO • Botanique • 387 Pitcher Plant Lane • Stanardsville, VA 22973 USA •
<http://www.pitcherplant.com>

Keywords: Ecology: Cultivation: *Nepenthes*.

Introduction

One of the most difficult things to describe to someone is how to grow a plant that is restricted in its tolerances. Partly to blame is our human perception of these conditions. What exactly is “bright light”? What is “clean water” and how acidic is “acid”? Highland *Nepenthes* are often one of the more perplexing groups to work with. What seems to work for one person fails when someone else tries to reproduce the cultural environment. *Nepenthes villosa*, for example, is not an easy plant to grow from seed; it has a narrow range of conditions necessary to grow well. Beans are easy to grow, highland *Nepenthes* are not!

In order to get better insight into the needs of several species, I conducted five years worth of experiments aimed at quantifying their needs. Instead of subjective terms, I used tools to measure environmental conditions in all test groups. A light meter, conductivity meter, pH meter, recording thermometers and a high quality humidity meter were employed to put some numbers behind the findings. (Cheap meters are dangerous to rely on, so only meters that could be calibrated and tested were used.) This way, anyone could nearly duplicate the conditions that were successful, and avoid potential disaster by measuring variables before plants get put into a bad environment.

The following *Nepenthes* were used in this study: *N. burbidgeae*, *N. edwardsiana* (Tambuyukon type), *N. fusca*, *N. stenophylla*, *N. tentaculata* (Mt. Tambuyukon type and Mt. Kinabalu type), and *N. villosa*. All were raised from donated seed or very tiny seedlings (cotyledon spread 0.63 cm., 0.25 inch). Dead or struggling plants were considered indicators of exceeding the species tolerance to one or more variables within their environment. The bane and beauty of using seedlings is that they do not take long to indicate improper environments; they die quickly!

Several points deserve mention, before getting into the “meat” of this article. First, plants grow in a system, where the elements of culture play off each other. For example, higher light levels require greater nutrient levels, as plants need more nitrogen to eliminate photosynthetic (waste) byproducts. Stresses from lower relative humidity might be offset by lower light or more available moisture at the root zone. Thus, I am not suggesting one rigid method, when explaining a successful technique. My intention is to give benchmarks and warning signs.

Second, this article was written as a distillation from five years (1996-2001) worth of records. A full description of these experiments would fill several volumes of this newsletter with tedious detail. My intention is to present a simplified summary of what happened during these experiments. One example of this practical focus was to simplify the complex science of light. The usual grower purchases a readily available light source or uses sunlight. The intensity of the illumination striking the plants is determined by the light source, the distance from the source to the plants, and/or the amount of shading. The simplest way to get a reasonably accurate measurement of intensity is to use a light meter, specifying the unit of measure and the source (very important). For spectral analysis of artificial lights used herein, contact the manufacturer.

Finally, it is important to note that, unlike formal experimental design, there were no control groups, per se. In many of these species, seedling death is the norm. Other growers, who worked with many of the same seed lots, reported complete losses in difficult species like *N. edwardsiana*, and *N. villosa*. Thus, it was nearly impossible to assign a control group without first figuring out how to keep it alive! The main support for these findings is that significantly

large numbers of plants were used. The results herein are preliminary and not conclusive; other factors (such as bacterial infection, seed viability, genetics of the donated seed, etc.) could have had an effect on these findings. Readers should consider this article a detailed summary by a professional horticulturist, rather than a classic, formal experiment. As far as I am aware, this is the first time that meters have been used to quantify the major (growing) environmental parameters, and that these measurements have been united in print.

Experimental methods

Seedling lots were from two hundred to four hundred seedlings per species. The seedlings were carefully transplanted into groups of 32 per 10.2 cm (four inch) plastic pot at the cotyledon stage of seedling development. Lesser quantities of seedlings were put into the same size pots when I intended to expose these to extreme, probably fatal conditions (such as pH below 4.5, or light below 4300 lx, i.e. 400 fc), or when the seedlings grew enough to need extra space. These "community pots" were then placed into different, carefully monitored environments (including different media). Groups were examined monthly and compared visually. It was obvious which groups were prospering and which were dead or growing poorly, so I did not measure each plant.

Meters included:

Conductivity meter (American Marine, Inc., Pinpoint™ Conductivity Meter) giving values in microsiemens/cm.

Light meter (Extech, model 40125), values were originally measured in foot candles and converted to lux¹.

Hygrometer/Thermometer (Extech model 44470), values given as relative humidity (RH).

Min/Max thermometers (Taylor), temperatures were originally recorded in degrees Fahrenheit.

Artificial light sources included:

High pressure sodium (Philips, SonAgro, 430W).

Metal halide (Philips, AgroSun™, MS400/HOR/AS, 400W).

A fluorescent combination using 50% Wide spectrum Gro-Lux® (Sylvania, 40W) plus 50% Interior Designer® cool white (Sylvania, 40W).

Greenhouse shading for sunlight was accomplished using Continental Products® Koolray Easyoff. This horticultural liquid shading was diluted/applied/removed as necessary to maintain fairly consistent light levels. Artificial light sources were on for fourteen hours per day (24 hour cycle). Unlike day length supplied by artificial lighting, seasonal day length determined the photoperiod in groups getting sunlight.

All plant groups used in this experiment were given identical preventative fungicide treatment to discourage pathogens from degrading the test groups. A mixture of Zyban® (4 ml/liter, 1 TBS/gal.) plus Subdue® (1.6 drops/liter, six drops/gal.) were lightly misted over seed or seedlings, once every two months. Every other application, Cleary's 3336® (4 ml/liter, 1 TBS/gal.) was substituted for the Zyban to reduce the total chemical load. (Zyban® is the same as Cleary's 3336® plus Mancozeb®.) *Nepenthes* seedlings are subject to damp-off. Usually, damp-off is caused by species of *Pythium* or *Rhizoctonia*. *Botrytis* and several other fungi are usually less common as damp-off culprits. Pathogen identity was primarily determined by examining conidia under compound microscope. Non-systemic fungicides, such as Captan®, were not used because they are less effective and the concentration needed for pathogen control raised the conductivity of the soil to deadly levels². Mortality rate of untreated seedlings (two months after germination) was between ten and eighty percent, so untreated groups were not used in these experiments. Mortality rate of fungicide-treated seedlings was generally below ten percent (two months after germination). Twenty-four hours after fungicides were applied, all media were leached with purified, aerated water, to remove soluble residues.

¹Values given in lux can be converted to foot candles using 1 lx = 0.0929 fc.

²My thanks to Dr. Jay Stipes, VA Polytechnic Institute, for assisting me in finding an effective fungicide combination.

Another hidden seedling killer proved to be salts that slowly leached out of perlite, one of the main media components. Perlite is hydrated obsidian that is heat treated to expand. Perlite was added to purified water (two parts water to one part perlite) and the conductivity of the water increased more than threefold, over a two day period. Since all examined groups of seedling *Nepenthes* seemed to favor a conductivity level in the soil of between 10-20 microsiemens; the perlite was pushing the conductive load of the media to dangerous levels (24-75 microsiemens). However, after repeated leaching the perlite became a great, inert material to use in seedling media mixes. Certainly, the quality of perlite is variable.

The irrigation water was purified by reverse osmosis and aerated using a utility pump. The conductivity of the water was 10-12 microsiemens. Eighty percent of all groups were watered twice a month with a boiled, strained, peat moss and sphagnum water extract (tea) which was added to irrigation water prior to aeration. The formula, pH and conductivity levels of this diluted tea were monitored and standardized for the tests. The tea was used to add nutrients, regulate soil pH and examine the effects of conductivity in an organic, acid matrix (media containing primarily tannic, fulvic and humic acids as acidifying agents). Conductivity values given here are from water extracts of potting media. Water extracts from the media were made by saturating the media for one hour and passing purified water (approximately equal to the soil volume) through the media. This leachate was measured for pH and conductivity. As one might expect, the make-up of water ultimately determined the conductivity of the media. The breakdown and leaching of organic materials in the media did not elevate conductivity significantly, i.e. organic compounds tend to yield low conductivity products as they leach or decompose. It may be helpful for readers to imagine a hydroponic model, where the water chemistry has more effect on soil chemistry than the media. This is especially true in media consisting largely of perlite. It is also important to note that the effects of conductivity relate to pH in terms of seedling tolerance; if the pH of the media is outside a plant's preferred range, higher conductivity values tend to make the stress worse (higher death rates). When "optimal" conductivity values are given, these are what appeared optimal at suitable pH.

All right, before this sounds too much like a physical science treatise...on to the plants!

Results on specific plants

N. burbidgeae was fairly broad in its tolerances, especially in regards to soil types and temperature. This species tolerated every media blend used. Stunted growth was evident with 50% silica gel, 10% peat moss chunks, and 20% each sphagnum and fir bark. The best growth rates were in media consisting of 50% perlite (leached), 10% peat moss chunks, 10% fir bark and 30% sphagnum moss (dead, long fiber). Media with no fir bark and higher percentages of sphagnum worked equally well. Plants tolerated temperature in the range of 9-41°C (48°-105°F), but grew about 50% slower, with fewer pitchers, when night temperatures were consistently over 18°C (65°F). The best growth occurred when temperatures were 20-29°C (68°-85°F) during the day, and 12-16°C (54°-60°F) at night. Optimal pH was 4.8-5.5. (Slower growth was observed at a pH of 3.5.) Optimal conductivity was 10-24 microsiemens; foliar burn appeared after prolonged exposure (one week or more) to levels above 60 microsiemens. Relative humidity seemed best within the range of 68-95%. Constant high humidity (over 90%) encouraged disease outbreaks and higher death rates, especially in seedlings less than one year old. Preferred light levels were 7000-9700 lx (650-900 fc) under high pressure sodium, 6500-9100 lx (600-850 fc) under metal halide, 5400-7300 lx (500-680 fc) under the fluorescent combination, and 70-93 lx (750-1000 fc) under sunlight. Plants survived lower light levels, but poor pigmentation and etiolated growth was observed. Plants responded well to dilute Miracid® fertilizer, applied monthly to the pitchers³. Light misting (foliar feed) of the same solution, monthly, had no noticeable effect on the plants.

³Miracid®, when used, was usually applied at 1/4 the labeled strength for house plants, 0.3 ml/liter approximately equals 0.2g/liter (1/4 tsp/gal. approximately equals 0.75g/gal.). Purified water was used. The solution was put in each opened pitcher, filling the pitchers to the top (peristome).

N. edwardsiana was, without question, the most fragile seedling observed, although the plants became much sturdier as they aged. The following conditions were concurrent with 100% mortality in cotyledon stage seedlings: constant high humidity (over 90% RH), water droplets sitting on leaves or crown, conductivity over 45 microsiemens, and pH above 6. This test group was the smallest (after two months), but a few plants were growing gloriously well in 50% perlite, 10% peat moss chunks, 10% fir bark and 30% sphagnum. In addition, a top dressing of live sphagnum proved very helpful; many of the roots weaved through this layer. Optimal soil conditions appeared to include a pH between 4.8-5.4, and conductivity at levels below 24 microsiemens. Humidity appeared best between 65-85 RH, although older plants (one year or greater) tolerated brief (1-3 days) exposures to 90-99% RH. Under high pressure sodium, light at 7500-9100 lx (700-850 fc) seemed optimal. Other light sources were not tested. Due to the fragile/valuable nature of the few plants, only insects were fed to the plants. When the pitchers were about 3 mm (1/8 in.), dried fruit fly (*Drosophila melanogaster*) larvae were used as food. As the pitchers grew, ants (*Acanthomyops* sp.) were used as food. Plants grew most vigorously when night temperatures were 13-16°C (55-60°F) and day temperatures ran 21-29°C (70-85°F). Growth was very slow for the first 8 months; as the plants reached 2 cm (3/4 inch) in diameter, the growth rate went up dramatically.

N. fusca proved to be very tolerant of cultural variances. None of the test groups showed greater than 25% death rates, except seedlings raised without fungicides, which had from 10% to 100% death rate. This death rate appeared to be random. Although the seedlings survived all the cultivation conditions I subjected them to, some patterns indicating preferences did occur. Media containing higher organic components performed better, i.e. 30% perlite, 10% peat moss chunks and 60% any combination of sphagnum and/or fir bark. A slightly more acidic condition was preferred, from 4.5-5.0 pH. Conductivity tolerances showed good growth between 10-45 microsiemens. Humidity was optimal from 65-90% RH. Though the seedlings tolerated from 10-38°C (50-100°F), growth and pitcher production was poor when nights were routinely over 21°C (70°F). Lighting experiments yielded the following: metal halide, high pressure sodium and sun-light all performed best from 6400-8600 lx (600-800 fc). However, the most vibrant colors were obviously in plants grown under 50% Gro-Lux® and 50% cool white fluorescent at 5400-7500 lx (500-700 fc). Some plants grown for several months under sun, metal halide or hp sodium were moved to the above fluorescent combination with dramatic results; green leaves turned bronzy, light reds became vibrant magenta and spotting on the pitchers became much darker. Growth rates, under all light sources, were similar. Miracid® at 1/4 strength (see Footnote 3), applied inside pitchers, was effective. Ants worked as well for feeding.

N. stenophylla was the slowest overall performer, and I am not certain I ever found ideal conditions for growing it. Generally, the plants grew reasonably well but very slowly, although about 10% of the plants, within a group, tended to grow faster than the others. Despite the sluggish growth, the plants appeared healthy. Pitcher feeding seemed very important, but not all plants responded similarly; about 30% of a group grew 200% in six months, whereas the rest of the seedlings grew about 20% in six months. Miracid® (see Footnote 3), *Drosophila* larvae and ants were equally effective in feeding tests. Despite somewhat ambiguous results, plants grew reasonably well in media containing 40-50% perlite and 40-50% sphagnum moss; adding about 10% fir bark had no noticeable effect. Conductivity was best near 10-22 microsiemens; stress appeared at levels over 45 microsiemens. The pH observations were inconclusive. One plant (in a container with 5 other similar seedlings) took off at pH 4.0, while the rest appeared impaired. Most plants grew reasonably well at a pH of 5.0. All light sources worked well, but the best observed growth was under sunlight at 8600-12,000 lx (800-1,100 fc). Plants seem to resent water on the foliage and crown, when young; nearly 30% died if their tops were wetted routinely. Plants grew well at 65-90% RH and tolerated temperatures of 10-38°C (50-100°F). Best growth was achieved with nights at 13-17°C (55-62°F) and day temperatures of 24-29°C (75-85°F). Worth noting, the gradual appearance of mosses on the media surface appears to coincide with increased growth rate/plant health.

N. tentaculata from Tambuyukon and from Mt. Kinabalu behave like two different species. Though I am trusting the accuracy of the donors, the morphology of the plants supports the original, supposed ranges. Both types showed an affinity for acidic media, pH 3.8-5.0. In several cases, plants growing near a pH of 4.0 did better than those at higher pH. This was observed in

seedlings of Tambuyukon origin; Kinabalu type plants performed fairly equally from pH 3.8-5.0. Peat tea was found more useful in maintaining a lower pH and overall health in Tambuyukon plants. Both groups tolerated conductivity ranges from 10-40 microsiemens. A media of 30% perlite with 20% peat moss chunks and 50% sphagnum worked well for both types. Since these plants showed affinity to low pH, a few of each type were potted in pure peat moss, which had the dustier fraction removed. Despite early success, all plants grown in pure peat were dead after one year, whereas plants in better aerated media survived. As temperature ranges were increased, the differences in Tambuyukon and Kinabalu plants became dramatic. Kinabalu plants were much more tolerant of higher temperatures (10-37°C, 50-98°F). The Tambuyukon plants started dying when either the day temperature went much beyond 29°C (85°F) or the night temperatures stayed above 18°C (65°F). Whereas other species usually showed stress signs before dying, *N. tentaculata* from Tambuyukon often died overnight, with little or no warning. I could not help but be reminded of how *Darlingtonia* suddenly collapses after persistent warm media. Evident, as well, was a relationship between light and temperatures: the higher the temperature, the lower the light tolerance in *N. tentaculata* from Tambuyukon. Both races grew well under 6500 lx (600 fc) of the previously mentioned fluorescent light mix. Under high pressure sodium, 5400 lx (500 fc) was effective. Tambuyukon plants did poorly, but survived under metal halide (no optimal range observed), whereas Kinabalu types thrived at 6500-7500 lx (600-700 fc) of metal halide. Both types did well receiving from 6500-9100 lx (600-850 fc) of diffused natural light. Under the above light levels, Kinabalu plants thrived from 14-32°C (58-90°F); Tambuyukon plants did best from 10-26°C (50-78°F). In this study, *N. tentaculata* from Tambuyukon was the most sensitive species to high temperature, even more sensitive than *N. villosa*. It may be that the dark green leaves are subject to high heat gain, or that symbiotic relationships, especially at the root zone, are greatly influenced by temperature. Chelated iron availability may also be critical, as distressed plants showed foliar symptoms similar to iron deficiency. More study on this species is needed.

N. villosa had some unusual preferences in culture. For a cloud forest dweller, this species showed a high death rate when seedlings were misted or kept at very high humidity (> 90% RH) for long periods (a week or more). Optimum humidity levels were 65-85% RH. Though the plants tolerated warm nights to 24°C (75°F), the plants stopped growing well when nights were above 17°C (62°F). Many seedlings stayed the same size for over one year, when constantly exposed to nights between 17-24°C (62-75°F); most of the plants in this group ultimately died. The best plants were grown with night temperatures near 14°C (58°F) and day temperatures from 21-29°C (70-85°F). *N. villosa* proved very sensitive to conductive water or media, needing a range below 25 microsiemens to grow well. Seedlings exposed to foliar Miracid® at 1/4 strength and 1/6 strength died within two weeks (see Footnote 3). Seedlings 3/4 inch or more in diameter, however, responded well to the above solutions when placed only in half (some) of the pitchers. Ants proved to be effective, as did dried *Drosophila* larvae. Because of the low nutrient level of the media, pitcher feeding appeared critical for plant health. Since the tiny seedlings make pitchers too small to feed with insects (practically speaking), I developed a technique to deliver the dilute Miracid® into pitchers 3mm (1/8 inch) tall, or less. Hair, from Whitetail deer (*Odocoileus virginianus*), was clipped to 3mm (1/8 inch) and soaked in the fertilizer. Since deer hair is porous in all directions, it proved an effective carrier for the nutrients. One or two hairs could easily be put into a tiny pitcher, once the pitcher lid was removed. Of the seedlings given this treatment, 75% showed significant growth rate increase. However, the other 25% usually died. When media with significantly higher organic/nutrient levels were used, the plants died. Often the low nutrient uptake of the seedlings created an ideal environment for blue-green algae to form a pellicle on the media surface. Aside from possible phytotoxic compounds, this pellicle decreased oxygen supply to the roots. In every test lot, *N. villosa* displayed an affinity for extremely well oxygenated media, or media with very high porosity. The best plants were raised in 75-80% perlite, with the remaining fraction sphagnum and peat moss chunks. Peat tea was used periodically to maintain a pH of 4.8-5.0 and a conductivity of 10-18 microsiemens. Plants given media at pH 3.8-4.0, (conductivity 28-41 microsiemens) were stunted. A thin top dressing of live sphagnum seemed to help, but was not as useful as in *N. edwardsiana* culture; the *N. villosa* did not root (much) directly into the live moss.



Figure 1: Tiny *Nepenthes villosa* seedlings being manipulated with a pair of forceps.

Although other growers have been successful using metal halide as artificial lighting, I was not able to get satisfactory growth with ranges of 8100-12000 lx (750-1100 fc). Much better growth was achieved using natural sunlight 8600-11000 lx (800-1000 fc), the fluorescent light combination mentioned earlier 7300-8100 lx (680-750 fc), and high pressure sodium 8400-9700 lx (780-900 fc). When a single fluorescent (2-40 watt bulbs, as described earlier) was angled to add to the high pressure sodium spectrum, colors and general plant health was improved. This is interesting, since the fluorescent lights only added about 900 lx (80 fc), when used in this fashion. Plants growing under the high pressure sodium/fluorescent combination grew faster and produced more pitchers.

Concluding comments

Shortly after this study was completed, Dr. Perry Malouf (personal communication⁴) did some limited soil analysis on Mt. Kinabalu, examining samples from near the root zones of several *Nepenthes* species. His preliminary findings on conductivity and pH in the field were very similar to those found to be near optimal in these seedling experiments. In general, *Nepenthes* seem to favor a soil pH near 5 with very low conductivity.

It is hoped that this information will help growers achieve success in their efforts and that ecologists can use the quantified data such as acid tolerances and conductivity to better predict when a *Nepenthes* habitat is threatened by factors such as acid rain, fertilizer runoff or deforestation. Acid rain can have a pH less than 3, and I have measured conductivities of over 70 microsiemens in Virginia's polluted rainwater. I am concerned that the increased use of high sulfur coal, as fuel in China and surrounding countries, will introduce acid rain to highland habitats. The reckless disregard for pollution, that has killed fish and most of the high elevation spruce forests in Virginia, could manifest itself in places like Mt. Kinabalu and Mt. Tambuyukon, transforming the currently vibrant ecosystems into ecologically damaged mountainsides. With the rapid development of the Eastern hemisphere, I fear many of us will live to witness such a tragedy. Monitoring rain water quality in montane habitats may prove vital in preventing habitat destruction by an invisible threat. Minimizing the risks is key to avoiding loss of species diversity.

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